May 10, 2004
NW Fisheries Science Center
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Dear Interested Party:

This is the second version of draft documents developed by NOAA Fisheries' Northwest Fisheries Science Center for NOAA Fisheries Regional Office in support of the FCRPS Biological Opinion Remand effort. We hope that you can help us achieve appropriate distribution and review of this and subsequent documents as a first step in better coordinating the NWFSC's analyses with the important habitat work being conducted at the local and subbasin levels.

The NWFSC's effort is intended primarily to address the question: What is the likelihood that population or ESU status can be favorably affected by improvements to estuarine and tributary habitats? We are taking a three-step approach to answering this question: 1) estimate status of habitat processes historically and currently; 2) evaluate current and historic fish population status; and 3) characterize populations with respect to their habitat and fish status. This draft describes each of these steps.

We are distributing draft components of the analysis for review sequentially, as completed, rather than a single final product. We hope that this early distribution will foster productive review and discussion, enhance opportunities for these analyses to be useful to local assessment efforts, and ultimately improve the quality of our effort. In this spirit, comments aimed at the logic of our approach and substantive problems with our results and conclusions will be particularly useful. Please keep in mind that this is a preliminary draft.

We would very much appreciate your comments and reviews of this document. Realizing that many potential reviewers are constrained by the subbasin planning deadline of May 28, we would appreciate any feedback by June 7. Please send reviews and comments to Michelle McClure, electronically at michelle.mcclure@noaa.gov, or at the mailing address above.

Thank you very much,

Michelle McClure   John Stein

Evaluating the Potential for Improvements to Habitat Condition to Improve Population Status for Eight Salmon and Steelhead ESUs in the Columbia Basin

Discussion Draft
May 7, 2004

INTRODUCTION

Objective and Task Description

In this paper, we present analyses in support of the 2004 FCRPS Biological Opinion Remand effort, aimed primarily at answering the question*: Is there potential to improve anadromous salmonid population status through improvements to habitat conditions in tributary or estuarine environments?* These analyses are intended to inform assessments of the potential for habitat improvements to effect positive change in salmon and steelhead population status.

Here we provide preliminary results for eight ESUs considered substantially affected by the FCRPS hydropower system in the 2000 FCRPS Biological Opinion (NMFS, 2000): Snake River spring/summer chinook (threatened), Upper Columbia spring chinook (endangered), Snake River fall chinook (threatened), Snake River steelhead (threatened), Upper Columbia steelhead (endangered), Mid-Columbia steelhead (threatened), Snake River sockeye (endangered), and Columbia River chum (threatened).

Approach to the analysis

To address this question, we conducted three types of analyses or evaluations. First, we used GIS-based assessments of tributary habitat conditions historically and currently to predict areas likely to be impaired with respect to habitat-forming processes. Second, we characterized estuarine habitat conditions with respect to the likelihood that current conditions negatively affect different life history strategies. Third, we evaluated current population status in comparison to historical population status for four characteristics important for long-term viability: abundance, productivity, spatial structure and diversity (McElhany et al. 2000). Because historical population characteristics are almost universally unknown, we estimated the "intrinsic potential" of the landscape to support chinook and steelhead, and used the results of this analysis as our hypothesis of historical population distribution.

After completing these analyses, we then categorized populations with respect to the degree and type of habitat problems identified and overall population status. In particular, we identified areas with minimal habitat or population status disruption – these areas may be important areas to maintain or protect. We also identified areas with extremely compromised habitat and poor population status – these situations are the areas where there is the greatest likelihood that habitat factors have negatively affected population status. However, necessary improvements to see changes in these fish populations may be substantial. Areas with moderately or minimally compromised habitat and poor population status may provide opportunities to improve population status with less effort, although these should be evaluated on a case-by-case basis to determine the likelihood that factors identified as impaired are strongly affecting survival or other population characteristics.

In addition to these core analyses, the next version of this paper will include several supporting analyses intended to further inform assessments of the potential for habitat improvements to effect positive change in salmon and steelhead population status. Specifically, it will include life-cycle modeling aimed at identifying the biological feasibility of achieving necessary changes to salmonid population or ESU status through survival improvements in the freshwater and estuarine life stages.

Scope of and Limits to the Evaluation

Our analysis is large-scale, encompassing all listed ESUs in the interior Columbia basin as well as Columbia River chum. This large focus brings with it several important considerations for each aspect of our evaluation.

First, our tributary habitat analyses are based largely on land use, and are aimed at identifying likely impairments or disruptions to natural landscape processes that appear to affect in-stream habitat conditions. Thus, they do not provide a detailed, local inventory of problems, but rather indicate areas where particular problems are likely.

Second, because our tributary habitat analyses are based on data widely available throughout the basin, the range of potential impacts we investigated was limited to sedimentation, riparian and floodplain corridor alterations, water quality (restricted to pesticide and herbicide applications), changes to in-stream flows, potential for entrainment in irrigation diversions, and barriers to passage. We do not address other factors, including (but clearly not limited to) exotic species, impacts of mining (either in-stream habitat alteration or water quality impacts), nutrient cycling, or nutrient cycling and availability. Local information about these additional impacts is clearly relevant and important for conservation planning efforts.

Similarly, our estuarine-habitat analysis examines a relatively limited number of potential impacts: flow, shallow-water habitat loss, toxics and tern predation. In addition, we do not provide population-specific evaluations of these impacts. Rather, our assessment of these impacts considers their importance to the life stages using the estuarine environments. ESUs are classified by their dominant life history strategy and how they use the estuary. We thus provide a general picture of the potential of key estuarine factors to affect population status for each ESU; as with our tributary analysis, additional factors we did not consider explicitly may also be relevant.

Finally, our assessment of the potential for the abundance, productivity, spatial structure or diversity of a population to improve is conducted by comparing current salmon and steelhead population status with a hypothesized historical distribution of those populations. A judgment that a population's status can improve for each of these metrics is independent of viability criteria currently being developed by the TRTs for the Interior Columbia (interior ESUs) and Lower Columbia/Willamette (Columbia River chum). It is instead an indication that a population's current status is substantially lower than it was historically, and could thus be improved.

Importantly, in spite of these considerations, our analysis does provide a consistent, population-level assessment of tributary and estuarine habitat factors generally thought to affect the health of salmon and steelhead populations. As such, it is a critical step in evaluating the likelihood that off-site mitigation actions aimed at habitat improvement have the potential to positively affect population health.

OVERVIEW OF METHODS

Tributary Habitat

Our basin-wide analysis of tributary habitat factor impairment includes an assessment of riparian and floodplain functions, erosion/sedimentation potential, in-stream flow regime, diversion entrainment, water quality and barriers to passage (in tributaries). These analyses are all GIS-based, and incorporated a range of information, from regional land-use/land-cover data to more local (generally statewide) information. They are intended to identify impairment to habitat-forming processes that influence in-stream habitat conditions. However, while each analysis is aimed at a particular process, additional impacts may be associated with these factors. In addition, each of these analyses is based on current land-use and data. Impacts that occurred in the past but that have been altered currently will not be indicated in these analyses.

Riparian and floodplain functions. Riparian areas provide many functions that contribute to habitat that is suitable for viability of salmonids, as well as the integrity of the stream network itself (e.g., temperature control, filtering capacity, large woody debris recruitment, bank stability). Connectivity of the stream and its floodplain provide necessary functions as well. This analysis is divided into two parts: first, an evaluation of stream-side buffer widths across different land use types using aerial photographs, and second, determining the proportion of streams falling within each land-use type. Two separate analyses were conducted: one aimed at floodplain areas, as determined by FEMA floodplain maps, and a second aimed at riparian areas not classified as floodplains. Impairments to normal temperature regimes may be associated with impairment or alteration to natural riparian functions.

Surface erosion on non-forested lands. Erosion on non-forested lands of the Columbia River basin is dominated by surface erosion and gullying processes, with relatively little contribution from mass wasting. Spatial variation in surface erosion rate is governed by several natural factors including hillslope angle, soil erosivity, rainfall intensity, and vegetation cover. Agricultural practices typically increase surface erosion by reducing vegetation cover and exposing more of the soil surface to rainfall impact and overland flow. We calculated an index of change in surface erosion rate for each population using current and reference land-use and land cover information.

Mass wasting and surface erosion on forested lands. A substantial literature concerning effects of forest practices (e.g., logging and road building) on mass wasting processes has established that clear-cut logging and road building significantly alter sediment supply rates from landsliding (e.g., see summaries in Sidle et al., 1985 and Meehan 1991). In general, sediment supply rates increase by an order of magnitude with logging, and another order of magnitude with road building, as compared to natural areas. Increased sediment supply rates due to roads are similar east and west of the Cascades, but increased rates caused by clearcuts may be higher east of the Cascades. Further, intense stand-replacing fires can dramatically increases erosion rates in forested areas of the Columbia basin (Megahan et al. 1995, Meyer et al. 2001), and much of that increase is due to elevated rates of mass wasting. We summarized an estimated difference between current and reference condition sediment supply for each population using road density, timber harvest rates and land-use and land cover information.

In-stream flow regime. Water withdrawals in the Columbia River basin substantially alter stream flows experienced by many salmon populations. Available data indicate that most diversions in the Columbia River basin are for irrigation (Quigley and Arbelbide 1997), although it is currently not clear how much water is removed from streams. Data limitations include incomplete accounting of all diversions, withdrawals are not measured at each diversion, and return flows are difficult to account for. We used a database we compiled from several sources to estimate the potential proportion of water diverted (legal flow allocated within the population and in flow-providing areas upstream divided by mean flow during low flow periods) per population. Due to the data limitations associated with this factor, it is important to recognize that this metric is an index of potential impairment rather than an absolute measure. A high proportion of water potentially diverted may also be associated with relatively higher stream temperatures.

Diversion entrainment. In addition to altering in-stream flows, diversions have the potential to entrain outmigrating smolts in irrigation canals, thereby affecting survival of those outmigrating smolts. Data limitations, as with in-stream flows, include incomplete accounting of all diversions, withdrawals not measured at each diversion, and a lack of information about the presence or status of screen on any diversions. We therefore treat the number of diversions each population encounters as a relative measure of the impact of entrainment on the population. We calculated the number of diversions within the population boundary and on its downstream divert migration path. In addition, we estimated the proportion of the stream flow diverted at each intake/diversion, based on the legally allotted flow for that diversion, since the potential for entrainment varies with the proportion of water removed from the stream (Neely 2000). While this analysis was aimed at identifying locations with a high potential for entrainment, these areas (high in the number of diversions) may also be associated with stream reaches likely to be channelized.

Water Quality (Pesticide). Pesticides are frequently detected in salmon habitat throughout the Columbia Basin. For example, 50 different pesticides were recently detected by the U.S. Geological Survey in the Willamette basin (Wentz et al., 1998), and 43 different pesticides have been detected in the lower Yakima River (Rinella et al., 1999). Sub-lethal effects of these pesticides on salmon survival and reproductive health are largely unknown, especially when they enter streams in complex mixtures. Trace metals and petroleum-based products also enter surface waters in high concentrations in urban areas (Wentz et al. 1998), and their effects on salmon are also poorly understood. Recent studies indicate that at least some of these compounds dramatically alter olfactory-mediated behaviors in salmon (Scholtz et al. 2000), which can result in increased mortality during juvenile life stages. The potential for increased mortality combined with high exposure potential creates a critical uncertainty in our ability to identify actions necessary to improve population status. We calculated an index of likely exposure to pesticides based on land-use patterns and associated pesticide use.

Barriers. Many anthropogenic barriers, including culverts and diversion dams have blocked passage to previously accessible habitats either completely or partially. The states of Oregon, Washington and Idaho have begun inventories of these barriers. Unfortunately, however, it is frequently unknown whether a particular barrier blocks access completely. We calculated the proportion of historically available stream km that are currently inaccessible under two scenarios: first, assuming that only barriers known to be complete barriers blocked passage, and second, a worst-case scenario, assuming that all barriers categorized as “unknown” for degree of passage were complete barriers. We calculated stream km both as an absolute measure, and weighted by historical habitat quality. [Note that this analysis was particularly plagued by lack of specific, local information. We are currently engaged in a comparison of the statewide databases and more detailed, local information provided to us by several subbasin assessment groups.]

For each of these analyses, we calculated the range of divergence from reference conditions across all populations within a species. Scientific research to date does not support the identification of a cutoff below which impacts from any of these factors to affected populations is minimal. Therefore, we divided the range of values for each factor into ten equal bins and ranked each population according to which bin it fell in for each factor. This binning allowed us to characterize the relative degree of divergence from reference conditions between populations. Because of the range of conditions present in the basin (from designated wilderness areas to highly altered landscapes), we assume that the range within each factor is associated with the likelihood that the factor has the potential to affect population status.

More detailed methods, data sources and descriptions for each of these tributary habitat analyses can be found in Appendix A.

Estuary Habitat

We also characterized changes in estuarine and plume conditions for four factors: flow, shallow-water habitat availability, toxics and tern predation. For each factor, we synthesized available information from the scientific literature and agency reports. We then generated a relative ranking of the impact of each factor on stream-type ESUs and ocean-type ESUs separately (Appendix B).

Population Status Assessment

We compared historical and current population abundance, productivity, spatial structure and diversity to determine whether values of each of these parameters had declined substantially, indicating that there is the potential to improve population status. Obviously, historical conditions are unavailable in virtually every case. We therefore estimated the intrinsic potential of the landscape to support salmon and steelhead, and used the results of this analysis as our hypothesis of the distribution of salmon and steelhead historically. This comparison does not consider whether current conditions or some point in between current and historical conditions could be considered viable, but rather only whether it is possible to increase the values of each of these parameters, assuming that historical values were a maximum potential.

Estimating historical distribution. Because the historical distribution of salmon and steelhead is known only generally, we generated a hypothesis of the historical distribution of stream-type chinook and steelhead using landscape features. Specifically, we rated each 200m stream segment in the interior Columbia basin as high, moderate or low in its intrinsic suitability for rearing (i.e. before anthropogenic impacts). Factors considered in this analysis included stream gradient, stream width, valley width and (historical) vegetation type, with specific ratings tailored to stream-type chinook and steelhead. (See Appendix C). For chinook, rearing potential appears to be substantially correlated with spawning potential (Luneta et al. 1997). This method of estimating intrinsic potential is consistent with analyses estimating potential capacity conducted by the Puget Sound and Lower Columbia/Upper Willamette TRTs. For chum salmon, we used a similar analysis conducted by the Lower Columbia/Upper Willamette TRT (REF). Currently, for Snake River Fall chinook, historical distribution (for comparison with current) is based on historical accounts (e.g. Gilbert and Evermann 1897). We are working to integrate the results of more recent studies (e.g.Connor et al. 2001; Dauble and Geist 2000) to estimate likely spawning and rearing distribution for this ESU at a finer scale.

Importantly, we recognize that this analysis cannot provide a perfect picture of historical distributions, since local factors other than these landscape features may influence local suitability. It is intended rather, to provide a general picture of salmon and steelhead distributions before European contact.

Current distributions. We used GIS layers available on Streamnet and refined with layers provided by Idaho Fish and Game, Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife to describe current spawning and rearing distribution. In a small number of cases, we have discovered errors in these data layers. For consistency, however, we are using these layers as they were provided (i.e. we have made no changes), and are noting those errors.

We took the following approach to comparing historical and current population status for each viability-related parameter:

Abundance/Capacity. We evaluated two characteristics of abundance and capacity. First, for those populations for which a total population estimate was available, we calculated the geometric mean number of spawners for the last five years of the time series. An abundant literature suggests that a population size less than 500 is subject to a variety of demographic and genetic impacts severely limiting viability. Therefore, we judged that any population with less than 500 spawners (geomean over five years) had potential for improvement with respect to abundance. For all populations, we also calculated a capacity metric, based on our intrinsic potential analysis (see Appendix D). If the value of this relative metric currently was 75% or less of the value historically, we considered the population to have potential for improvement with respect to capacity.

Productivity. To evaluate current productivity, we used four metrics used by the Biological Review Teams (BRT) during the 2002/2003 status reviews: short-term trend, long-term trend, long-term population growth rate, assuming hatchery fish do not contribute to subsequent generations and long-term population growth rate assuming that hatchery fish do contribute to subsequent generations (see Appendix D). Because it is essentially impossible to gauge a population's historical productivity, we judged that a population had potential to improve with respect to productivity if any one of these metrics was less than one (i.e. the trend or growth rate was declining). For many populations, data were not available to calculate productivity metrics. In these cases, we noted the lack of data; for categorization purposes, weassumed the average of each productivity metric across populations within the relevant ESU. The mean population growth rate of a group of populations is a robust indicator of the central tendency of that group (Holmes and Fagan 2002).

Spatial Structure. We used three metrics to gauge whether there was potential for a population's spatial structure to be improved. First, we calculated the percent of the potentially suitable habitat that is currently occupied; any value less than 66% was deemed as impaired (having potential for improvement). Second, we calculated the distribution of distances between spawning areas and determined whether there was a significant difference between the historical and current distribution. Any significant difference was deemed to be impaired. Finally, we examined the range of distances between spawning areas; any substantial reduction in this range was judged to provide potential for improvement (see Appendix D). A population was deemed to have potential for improvement if any one of these conditions was met.

Diversity. Because relevant life history, genetic and morphological diversity has not been characterized for most populations, we relied on habitat differences, characterized by ecoregion as a proxy for the potential for a population to express relevant diversity. We devised a diversity metric that considered both the number of ecoregions and the distribution across those ecoregions (see Appendix D.) If the historical value was greater than the current value of this metric, we considered there to be room for the population to improve with respect to diversity.

Appendix D contains further details of our current status assessment.

RESULTS OVERVIEW

Tributary Habitat

Detailed results for each tributary habitat analysis are presented in Appendix A. Below we present general results.

Riparian and floodplain functions. Riparian and floodplain corridors in agricultural and urban areas had substantially smaller buffers than riparian and floodplain areas in other land-use types. Areas with a particularly high proportion of riparian and floodplain corridors in these two land-uses included the Umatilla and Walla Walla, portions of the Grande Ronde drainage, the Pahsimeroi River and a substantial portion of the lower Columbia occupied by chum salmon (see Figure Sets 1 and 2).

Surface erosion on non-forested lands. Populations with the greatest increase in potential sedimentation from reference conditions for non-forested lands included those in the lower reaches of the Snake River, the Walla Walla and Umatilla, and the Cowlitz, Scappoose, Salmon and Washougal in the Lower Columbia (for chum) (Figure Set 3).

Mass wasting and surface erosion on forested lands. Mass wasting and surface erosion increased most dramatically for populations in the upper reaches of the John Day River, the Klickitat River, some areas of the Grande Ronde and nearly all of the areas occupied by Columbia River chum salmon (Figure Set 4).

In-stream flow regime. Areas with the greatest proportion of mean low flow that is legally allotted include the lower elevation areas of Central Oregon, as well as the Walla Walla, Umatilla, portions of the upper Salmon River, the Upper Yakima and the Okanogan. (Figure Set 5).

Diversion entrainment. Populations with the highest potential for diversion entrainment included those in the Okanogan and Methow Rivers, portions of the Grande Ronde, the Lemhi and other areas in the upper Salmon River. Again, data made available to us did not include information about current screening status, so this assessment is properly viewed as a relative measure of the potential for entrainment. Local information, when available, can help refine this evaluation (Figure Set 6).

Water Quality. Those populations with the highest likely exposure to pesticides were located in the lower Snake River basin, portions of the Upper Columbia in the interior basin, and in about half of the areas occupied by chum salmon populations (Figure Set 7). This water quality metric is very coarse, and provides only a relative measure of potential pesticide impacts.

Barriers. Our evaluation of areas rendered inaccessible by anthropogenic barriers was limited by data availability. Thus, our results should be viewed as an initial investigation of blocked areas rather than a definitive analysis. [Note that we are currently engaged in an explicit comparative analysis for several subbasins using locally-provided barrier data.] While several populations have been extirpated by anthropogenic barriers (White Salmon River steelhead, North Fork Clearwater steelhead, one or more steelhead populations in the upper Deschutes drainage), the majority of populations, with a few exceptions, did not appear to have large amounts of habitat blocked. The most affected chinook population was Catherine Creek, with up to 19% of historically available stream miles blocked. Camas Creek, the Entiat River and the North Fork Salmon River also had relatively high proportions of blocked area, in comparison with other chinook populations. The range of area blocked was somewhat higher for steelhead, with the Umatilla River population having nearly 40% of historically available area potentially blocked (Figure Set 8).

Here we have presented relative values (Figure sets 1-8); absolute values for each of these factors for each population are presented in Table 1. Finer-scale resolution of the results (i.e. not summarized at the population level) are provided in Appendix A.

Estuary Habitat

Our review of available information suggests that ESUs are affected differentially by estuarine factors, based on their dominant life history strategy and use of the estuary. In particular, ESUs with a dominant stream-type life history are most strongly affected by tern predation and flow (through its impact on plume habitat). Both these factors were ranked as medium in our rating scheme (see Appendix B). ESUs with a dominant ocean-type life history, however, were most affected by changes in shallow-water habitat and in the flow regime (mediated in this case through its impact on habitat quantity and quality). Both these factors were ranked as high, with toxics scored as a medium factor. See Appendix B for further details.

Population Status Assessment

We also examined the number of viability-relevant parameters that showed the potential for improvement on a population-specific basis (Table 2). Consistent with listing under the Endangered Species Act, all populations in the interior Columbia basin listed ESUs showed that current population status was significantly lower than historical status (by our metrics) in at least one parameter. One Columbia River chum population

(Elochoman) had minimal potential for improvement in any parameter. Across all eight ESUs, slightly over 17 percent of the populations showed potential for improvement in all four parameters. (This count considers parameters for which no data were available to be unimpaired.) Further details of current population status are provided in Appendix D.

DISCUSSION AND SYNTHESIS

Tributary Habitat

Tributary habitat throughout the interior Columbia River basin has sustained substantial impacts (Figure Sets 1-8). Interestingly, although the majority of our habitat factor evaluations relied heavily on patterns of historical and current land use, the impacts for each factor are not distributed identically across the basin. It is important to remember however, that our analysis identifies the potential or likelihood that habitat processes are impaired. Ground-truthing and refining our assessment will be an important next step.

We counted the number of factors (excluding barriers to passage) that were impaired in each population in order to identify areas that appear to be highly compromised and those with minimal habitat impacts (Table 4). We applied two standards to gauge impairment. First, we counted only those factors with a score of 8 or greater (i.e. in the upper thirtieth percentile) as impaired. Because the distribution of degree of impairment tended to be highly skewed, with most observations falling in the lower (relatively unimpaired) bins, this standard has the effect of identifying those situations in which the degree of impairment is relatively severe compared to the remainder of the basin. (We term this the "stringent" definition of impairment.) Next, we counted those factors with a score of 6 or greater (i.e. in the upper half of the range). This criterion (the "relaxed" definition of impairment) has the effect of identifying a broader range of factors that are impaired in any population. However, the likelihood that these factors all have the potential to make significant contributions to population status is somewhat lower, since the degree of impairment identified is lower.

Examining these cumulative impacts spatially reveals several interesting patterns. First, under the stringent criterion, a significant portion of the entire Salmon River basin as well as several populations in the Grande Ronde and Clearwater drainages show no habitat impacts at this level. On the other end of the spectrum, some areas within Grande Ronde, the Yakima, the Umatilla and the Walla Walla drainages, as well as some portions of the lower Columbia River show highly compromised habitats (Figure Set 9). Under the relaxed definition, highly compromised habitats are found in the Grande Ronde drainage, the Lemhi basin, portions of the South Fork of the Salmon, as well as throughout the Upper Columbia. Habitats without impacts at this level are restricted almost entirely to the Middle Fork of the Salmon River, which is largely included in designated wilderness areas (Figure Set 10).

Population Status

With this distribution of improvement potential, most populations are showing relatively poor overall population status. Those with 3 or more viability-relevant parameters impaired are distributed widely across the Columbia basin, with all extant populations in the Upper Columbia ESUs having the potential for improvement in all four parameters (Figure Set 11). We have not yet incorporated any information about the degree of change in any parameter from historical into our evaluation, although we are currently exploring ways of doing so.

Implications of Habitat and Population Status for Off-site Mitigation

We used our habitat and population status assessments to categorize populations with respect to the potential for habitat improvements to improve significantly population status (Tables 4 and 5). We did not identify areas with low habitat impairment to which anadromous salmonids do not currently have access. We will treat such areas in the next version of this paper. We identified three major categories:

- *Minimally compromised habitat*. No habitat factors were found to be above the impairment threshold for populations in this category. [Impairment threshold = upper thirtieth percentile for the "stringent" definition, or upper fiftieth percentile for "relaxed" definition.] There is likely little potential for actions in freshwater habitat addressing the factors we examined to improve population status substantially. (Although local information may identify We identified two subsets of this category.
    - *Relatively less poor current population status*. These populations had only 1 or two out of the 4 viability-relevant parameters impaired. Because of the combination of relatively less poor status and strong habitat conditions, these areas may be candidates to serve as "refugia" or to receive high priority for protection.
    - *Poor population status*. These populations showed potential to improve with respect to three or four of the four VSP parameters.
- *Highly compromised habitats*. Next, we identified highly compromised habitats (i.e. many factors identified as impaired within the population) with significant population losses. It is in these areas that there is the greatest likelihood that habitat process impairments have substantially affected population status. The greatest potential to improve population status through habitat actions thus also probably lies in these situations. However, the magnitude of effort required to achieve potential improvements is also likely to be large. In our next draft, we will identify populations of high intrinsic potential within this category.
- *Moderately compromised habitats.* Populations with moderately compromised habitats and significant population losses. Dependent upon the factors identified as impaired, there may be a lower likelihood that habitat conditions are substantially affecting population status in these situations. However, if there is high certainty that the identified factor is affecting the population, then the overall magnitude of restoration necessary may be

somewhat less than in highly compromised situations. We also identified one subset of this category.

- o *Habitat impacts restricted to biologically identifiable factors.* We identified those areas with significant population losses and habitat impacts restricted to in-stream flows and/or diversion entrainment. We singled this group of populations (a subset of the above category) out because the remedy for these problems is biologically straightforward. In the case of diversion entrainment, the impact on the population is also straightforward and readily identifiable (and therefore likely more certain). These may provide opportunities for restoration. [It is important to remember, however, that this analysis identifies the POTENTIAL for diversion entrainment to be a problem, not an actual measure, since data about the presence or quality of screens on diversions is lacking.]

These categories provide some general context for interpreting the potential for tributary habitat actions to affect positively population status. Those populations with minimally compromised habitat, for instance, provide little apparent opportunity for habitat restoration (across the range of factors that we examined); engaging solely in tributary habitat actions to improve population status in these cases would be a relatively high risk strategy, if local information does not indicate other problems. A lower-risk strategy for these populations would include actions with greater certainty of achieving a response. Those populations with highly and moderately compromised habitat are more likely to show a response to habitat improvements. Importantly, the likelihood of a response will be affected not only by the diversity of habitat factors impaired in an area, but also by the magnitude of change from historic conditions, the certainty with which changes (improvement) in a particular factor can be linked to population response.

ESU and Population-specific Discussion

Opportunities for off-site mitigation in tributary and estuarine habitats to improve population and ESU status varies from ESU to ESU. We discuss them individually below.

In the Upper Columbia spring chinook and steelhead ESUs, regardless of whether the stringent or relaxed definition of tributary habitat impairment is applied, all populations show some degree of habitat impairment. Thus, there are likely to be some opportunities to improve population status through off-site mitigation efforts aimed at freshwater habitats. However, the magnitude of these improvements is uncertain.

In the Snake River spring/summer chinook and steelhead ESUs, the situation is somewhat more complicated. Twenty-three to fifty percent of the populations in the chinook ESU, and eleven to thirty-five percent of the populations in the steelhead ESU in this drainage (dependent upon whether the stringent or relaxed criterion is applied) show minimal habitat process impairments over the range of factors that we examined. Notably, all the populations in one major population grouping of the spring/summer chinook ESU (the Middle Fork Salmon) are rated as having this minimal potential for improvement through tributary habitat actions. The remaining populations show some degree of opportunity to improve population status through off-site mitigation, with several showing impairment over many of the factors examined. These latter situations have the highest likelihood that habitat process impairments have substantially affected population status, thus providing off-site mitigation opportunities. However, as with the Upper Columbia spring chinook ESU, the magnitude of these improvements is uncertain. One particular note for this ESU: our analyses indicate that the South Fork Salmon River generally has a relatively low degree of impairment to habitat processes. However, this area has been notorious for sedimentation issues. This apparent discrepancy is due to the focus of our analyses on current conditions and practices (e.g. current timber harvest regimes, which are much reduced compared to historic timber harvest levels).

The Mid-Columbia steelhead ESU is somewhat less variable. Of sixteen extant populations, only 1-2 (dependent on the criterion) populations show minimal impacts, with the remainder having at least one factor classified as impaired. Populations in the Walla Walla, Umatilla and Yakima drainages are particularly highly compromised. Thus, although the magnitude is uncertain, there are likely to be some opportunities to improve population status through offsite mitigation efforts aimed at freshwater habitats in most major population.

All five of the above ESUs display a dominant stream-type life history strategy. Our evaluation indicates that there may also be some biological potential through reductions in tern predation or plume habitat (altered flow regime) to affect population status for these ESUs.

The Snake River fall chinook ESU generally showed minimal impact in the habitat factors we evaluated. However, these fish, which use mainstem habitats as a spawning area are more likely to be affected by other habitat factors, such as mainstem temperatures and flows. Thus, additional work (including synthesis of previous analyses) is called for in this case.

All populations in the Columbia River chum population showed some degree of habitat impairment by our analysis. Thus, as with the Upper Columbia ESUs, there is likely to be some opportunity to improve the status of component populations through habitat actions.

In addition, both the Snake River fall chinook and Columbia River chum use the estuary as relatively small (sub-yearling) fish. Our evaluation suggests that there may be additional opportunities in the estuary, through shallow-water habitat improvement, flow changes (affecting shallow water habitat) and reduction of toxic impacts for these ESUs.

The Snake River sockeye ESU, clearly challenged in many ways, shows minimal impact in the habitat screens completed. However, we have not yet conducted analyses relating to water diversions for this population. Nonetheless, opportunities for habitat improvement for this ESU are likely to be low.

Summary

This is a coarse-scale, basin-wide examination of a variety of tributary and estuarine habitat factors, and the potential for off-site mitigation aimed at those factors to affect population status positively. We found substantial variation between geographic areas in the likely degree of impact of these various factors. For example potential for forest sediment increases were most marked in the lower Columbia River, the east slopes of the Cascades and several forested areas in the interior basin, whereas impacts related to irrigation were concentrated in the lower elevation areas of central Washington and Oregon as well as the Lemhi River of Idaho. ESUs varied in the number and proportion of populations for which it was likely that there was biological potential for estuarine or tributary habitat off-site mitigation to affect population status. All populations in the Upper Columbia ESUs and the Columbia River chum had at least some habitat impairment. Snake River ESUs, however, had substantial portions, most notably in the Middle Fork of the Salmon River drainage, with no habitat impacts identified in this set of analyses (at the levels of "impairment" that we identified). Our analysis was limited, however, and did not include any assessment of impacts related to mining, nutrient cycling, and exotic species, for example (see also notes for specific analyses for limitations to specific analyses). Conditions in the estuary and plume appeared to have a differential impact on different ESUs, with those ESUs with stream-type life histories likely to be more affected by plume conditions and tern predation, and those ESUs with ocean-type life histories likely to be more affected by the quality and quantity of shallow-water habitat and toxics.

Table1. Population-level values for seven habitat factors examined. See Appendix A for details of specific analyses.

				NONFOREST SEDIMENT			Forest Sediment	Flood-plain		Riparian		*Toxics*	Diversions	
ESU	**Major Population Grouping**	**Current Pop. Code**	**Population Name**	**Historical**	**Current**	**Increase**	**INCREASE**	**Avg % area converted (potential range)**	**Avg % stream length converted (potential range)**	**Percent converted (current range)**	**Percent converted (potential range)**	**Avg water quality rating**	**Entrain-ment Rating (Number of Diversions)**	**Percent Flow Diverted**
Snake River Spring / Summer Chinook	Lower Snake River	SNASO	Asotin River	0.576	3.207	3.945	1.626	12.040	NA	0.000	20.320	1.297	318	0.1306
		SNTUC	Tucannon River	1.269	6.362	3.797	1.330	34.320	NA	3.391	41.311	1.395	340	1.4225
	Grande Ronde / Imnaha	GRWEN	Wenaha River	0.180	0.349	1.037	1.382	0.290	NA	0.000	0.000	1.001	304	4.7163
		GRLOS	Wallowa/Lostine Rivers	0.279	0.972	1.922	1.493	35.350	NA	46.425	25.478	1.192	535	4.5068
		GRLOO	Lookingglass Creek (historic)	0.008	0.042	1.034	3.264	0.001	NA	0.000	0.000	1.000	308	20.3537
		GRMIN	Minam River	0.290	0.773	1.232	1.063	0.110	NA	0.000	0.563	1.003	NA	NA
		GRCAT	Catherine Creek	0.354	1.043	1.877	1.906	48.360	NA	17.552	18.137	1.359	595	10.2401
		GRUMA	Upper Grande Ronde River	0.078	0.179	1.188	2.193	17.350	NA	0.000	0.597	1.077	390	0.2095
		IRMAI	Imnaha River	0.620	0.833	1.119	1.279	NA	NA	0.000	0.000	1.002	330	0.4488
		IRBSH	Big Sheep Creek	0.554	1.772	2.110	1.407	NA	NA	0.000	0.225	1.003	319	0.3911
	South Fork Salmon River	SRLSR	Little Salmon River	0.186	0.889	1.474	2.028	NA	33.793	0.368	11.945	1.025	479	12.0948
		SFMAI	South Fork Salmon River	0.125	0.145	1.003	1.360	NA	2.693	0.293	1.176	1.004	370	2.2799
		SFSEC	Secesh River	0.000	0.000	1.000	1.475	NA	0.000	1.136	0.591	1.000	348	0.0310
		SFEFS	E Fk S Fk Salmon River	0.007	0.007	1.000	1.414	NA	4.267	3.473	1.434	1.016	352	0.2470
	Middle Fork Salmon River	SRCHA	Chamberlain Creek	0.028	0.028	1.000	1.128	NA	0.000	0.000	0.338	1.001	347	0.3226
		MFBIG	Big Creek	0.555	0.555	1.000	1.058	NA	0.000	0.066	0.037	1.000	354	0.4139
		MFLMA	Lower Middle Fork Salmon River	0.980	0.980	1.000	1.009	NA	0.711	0.000	0.803	1.000	348	0.2453
		MFCAM	Camas Creek	0.161	0.161	1.000	1.070	NA	0.000	1.264	0.308	1.000	348	0.1301
		MFLOO	Loon Creek	0.231	0.231	1.000	1.034	NA	0.000	2.676	1.557	1.000	347	0.0169
		MFUMA	Upper Middle Fork Salmon River	0.189	0.189	1.000	1.024	NA	0.000	0.237	0.702	1.000	349	0.4280

				NONFOREST SEDIMENT			Forest Sediment	Flood-plain		Riparian		*Toxics*	Diversions	
ESU	**Major Population Grouping**	**Current Pop. Code**	**Population Name**	**Historical**	**Current**	**Increase**	**INCREASE**	**Avg % area converted (potential range)**	**Avg % stream length converted (potential range)**	**Percent converted (current range)**	**Percent converted (potential range)**	**Avg water quality rating**	**Entrain-ment Rating (Number of Diversions)**	**Percent Flow Diverted**
		MFSUL	Sulphur Creek	0.010	0.010	1.000	1.007	NA	1.139	4.638	2.438	1.005	347	NA
		MFBEA	Bear Valley Creek	0.028	0.028	1.000	1.046	NA	0.000	0.000	0.000	1.000	348	NA
		MFMAR	Marsh Creek	0.071	0.071	1.000	1.032	NA	0.000	0.000	0.369	1.003	352	0.1326
	Upper Salmon River	SRPAN	Panther Creek (historic)	0.193	0.193	1.000	1.396	0.000	0.961	1.679	1.373	1.000	367	1.2999
		SRNFS	N Fk Salmon River	0.198	0.198	1.000	1.640	NA	9.948	16.760	10.903	1.009	413	2.3686
		SRLEM	Lemhi River	0.607	0.690	1.062	1.230	NA	35.695	44.524	22.634	1.095	891	52.1599
		SRLMA	Lower Salmon River	1.192	1.209	1.007	1.193	11.930	22.472	21.144	13.102	1.047	804	36.8518
		SRPAH	Pahsimeroi River	0.916	0.922	1.004	1.145	5.920	17.292	37.941	12.986	1.054	574	34.2378
		SREFS	E Fk Salmon River	1.499	1.499	1.000	1.040	0.000	4.153	7.079	1.717	1.003	625	2.3177
		SRYFS	Yankee Fork	0.097	0.097	1.000	1.306	0.000	0.000	0.000	0.000	1.000	585	0.1933
		SRVAL	Valley Creek	0.126	0.126	1.000	1.239	1.780	9.056	11.144	12.056	1.046	625	1.1073
		SRUMA	Upper Salmon River	0.175	0.175	1.000	1.284	7.650	4.518	7.090	4.245	1.072	658	3.0944
Snake River Fall Chinook	Snake River	SNTUC	Tucannon River - North	0.226	0.410	1.075	1.313	33.220	NA	0.643	41.342	1.390	NA	NA
		SNTUC	Tucannon River - South	1.271	6.372	3.803	1.313	34.320	NA	17.332	41.311	1.390	NA	NA
		GRLMT	Grande Ronde River lower mainstem tributary	0.477	2.166	2.145	1.744	2.350	NA	0.000	12.611	1.146	313	3.6295
		CRLMA	Clearwater River lower mainstem	0.514	4.137	5.166	1.474	NA	NA	5.719	23.810	1.485	NA	NA
		SRLSR	Little Salmon and Rapid River	0.328	1.265	1.529	1.616	0.000	26.353	0.000	9.307	1.039	NA	NA
		SNHCT	Snake River Hells Canyon tributaries	0.788	1.484	1.359	1.252	NA	NA	0.000	0.000	1.005	NA	NA
		IRMAI	Imnaha River mainstem	0.618	0.834	1.122	1.279	NA	NA	0.000	0.000	1.002	NA	NA
Upper Columbia Chinook	Upper Columbia	UCENT	Entiat River	0.093	0.132	1.009	2.179	20.250	NA	5.746	6.860	1.059	580	0.5060
		UCMET	Methow River	0.130	0.225	1.064	1.603	4.290	NA	7.313	10.215	1.077	840	3.7405

				NONFOREST SEDIMENT			Forest Sediment	Flood-plain		Riparian		*Toxics*	Diversions	
ESU	**Major Population Grouping**	**Current Pop. Code**	**Population Name**	**Historical**	**Current**	**Increase**	**INCREASE**	**Avg % area converted (potential range)**	**Avg % stream length converted (potential range)**	**Percent converted (current range)**	**Percent converted (potential range)**	**Avg water quality rating**	**Entrain-ment Rating (Number of Diversions)**	**Percent Flow Diverted**
			Okanogan River (historic)	0.059	0.721	4.592	1.535	0.197	NA	16.969	8.679	1.227	NA	NA
		UCWEN	Wenatchee River	0.142	0.308	1.043	1.778	12.930	NA	1.860	12.121	1.178	581	1.7453
Lower Columbia Chum	Lower Columbia	GRAY-CM	Grays & Chinook Rivers	NA	0.016	1.166	3.728	11.230	NA	17.419	18.041	1.038	NA	NA
		YOUN-CM	Youngs Bay	NA	0.008	1.136	3.566	10.270	NA	19.515	16.068	1.076	NA	NA
		BIGC-CM	Big Creek	NA	0.014	1.245	2.909	25.720	NA	0.177	0.000	1.083	NA	NA
		ELOC-CM	Elochoman River	NA	0.037	1.427	3.164	32.670	NA	45.010	44.695	1.123	NA	NA
		CLAT-CM	Clatskanie River	NA	0.040	1.752	2.399	21.810	NA	11.912	4.336	1.272	NA	NA
		MILL-CM	Mill Creek	NA	0.017	1.309	2.497	7.200	NA	39.547	7.321	1.775	NA	NA
		COWL-CM	Cowlitz River	NA	0.065	2.039	2.638	31.290	NA	26.039	17.750	1.419	NA	NA
		KALA-CM	Kalama River	NA	0.012	1.043	3.486	9.390	NA	18.270	28.856	1.080	NA	NA
		SCAP-CM	Scappoose River	NA	0.100	2.439	2.285	31.110	NA	25.693	27.067	2.058	NA	NA
		LEWS-CM	Lewis River	NA	0.067	1.731	2.465	13.850	NA	20.717	27.581	1.314	NA	NA
		SALM-CM	Salmon Creek	NA	0.105	3.126	1.924	46.410	NA	53.751	61.253	4.390	NA	NA
		CLCK-CM	Clackamas River	NA	0.023	1.276	2.048	42.850	NA	67.918	64.381	3.936	NA	NA
		WASH-CM	Washougal River	NA	0.097	1.962	2.634	14.440	NA	15.640	20.836	1.490	NA	NA
		SAND-CM	Sandy River	NA	0.102	1.631	2.162	11.370	NA	22.870	16.962	1.650	NA	NA
		LGRG-CM	Lower Gorge Tributaries	NA	0.010	1.079	2.024	15.760	NA	16.426	14.382	1.070	NA	NA
		UGRG-CM	Upper Gorge Tributaries	NA	0.024	1.127	1.785	11.480	NA	6.149	27.677	1.230	NA	NA
Snake River Sockeye	Upper Salmon River	SRRED	Redfish Lake	0.252	0.252	0.000	1.057	NA	0.000	NA	NA	1.005	NA	NA
		SRRED	Alturas Lake	0.001	0.001	0.000	1.330	NA	0.000	NA	NA	1.010	NA	NA
		SRRED	Petit Lake	0.008	0.008	0.000	1.118	NA	0.000	NA	NA	1.030	NA	NA
Middle Columbia Steelhead	Cascade Eastern Slope Tributaries	MCWSA-s	While Salmon River (historic)	0.006	0.006	1.000	2.382	0.172	NA	0.438	0.190	1.124	30	0.2272
		MCKLI-s	Klickitat River	0.172	0.502	1.265	2.428	10.510	NA	NA	4.149	1.102	76	2.7417
		MCFIF-s	Fifteen Mile Creek (winters)	1.243	4.224	2.393	1.684	36.970	NA	16.191	25.054	1.391	231	1.4188

ESU	Major Population Grouping	Current Pop. Code	Population Name	NONFOREST SEDIMENT Historical	Current	Increase	Forest Sediment INCREASE	Flood-plain Avg % area converted (potential range)	Avg % stream length converted (potential range)	Riparian Percent converted (current range)	Percent converted (potential range)	*Toxics* Avg water quality rating	Diversions Entrain-ment Rating (Number of Diversions)	Percent Flow Diverted
		DREST-s	Deschutes River, Eastside	1.426	1.981	1.292	1.245	20.900	NA	3.168	9.054	1.110	95	13.9757
		DRWST-s	Deschutes River, Westside	0.531	0.636	1.072	1.460	1.510	NA	1.612	0.354	1.032	57	0.0003
			Crooked River - Above Pelton Dam (historic)	0.417	0.455	1.066	1.395	0.020	NA	5.803	3.102	1.077	NA	NA
		DRUMA-s	Upper Deschutes/Squaw creek - Above Pelton Dam (historic)	0.332	0.434	1.154	1.743	0.086	NA	4.851	3.933	1.220	NA	NA
		MCROC-s	Rock Creek	1.379	3.295	1.949	1.421	1.280	NA	0.000	1.922	1.101	47	NA
	John Day River	JDLMT-s	John Day River lower mainstem tribs	1.552	1.934	1.196	1.256	13.590	NA	6.207	17.028	1.134	412	15.5409
		JDNFJ-s	North Fork John Day River	0.363	0.486	1.072	2.126	5.330	NA	1.460	1.370	1.020	404	2.1755
		JDMFJ-s	Middle Fork John Day River	0.456	0.744	1.203	2.314	NA	NA	2.783	3.244	1.012	389	2.5975
		JDSFJ-s	South Fork John Day River	0.568	0.592	1.010	1.775	NA	NA	8.951	5.021	1.003	329	1.6886
		JDUMA-s	John Day upper mainstem	0.536	0.653	1.068	1.809	NA	NA	16.211	27.496	1.047	743	14.1521
	Umatilla and Walla Walla Rivers	MCUMA-s	Middle Fork Salmon River upper mainstem	0.573	2.374	3.365	1.360	32.400	NA	27.436	31.201	1.341	476	14.5825
		WWMAI-s	Walla Walla River	1.341	4.952	3.103	1.304	50.630	NA	34.798	72.102	2.056	964	37.3572
		WWTOU-s	Touchet River	1.751	7.234	3.523	1.174	58.480	NA	19.366	67.806	1.634	552	6.5470
	Yakima River Group	YRTOS-s	Toppenish ans Satus Creeks	1.326	1.742	1.199	1.503	5.190	NA	3.752	4.115	1.155	315	0.0910
		YRNAC-s	Naches River	0.286	0.608	1.153	1.736	24.170	NA	18.552	13.351	1.220	660	9.9676
		YRUMA-s	Yakima River upper mainstem	0.586	0.775	1.115	1.902	27.290	NA	10.071	24.738	1.207	823	33.8210
Snake River Steelhead	Lower Snake	SNTUC-s	Tucannon River	1.378	6.179	3.528	1.298	33.220	NA	6.833	41.342	1.385	343	1.4272

				NONFOREST SEDIMENT			Forest Sediment	Flood-plain		Riparian		*Toxics*	Diversions	
ESU	**Major Population Grouping**	**Current Pop. Code**	**Population Name**	**Historical**	**Current**	**Increase**	**INCREASE**	**Avg % area converted (potential range)**	**Avg % stream length converted (potential range)**	**Percent converted (current range)**	**Percent converted (potential range)**	**Avg water quality rating**	**Entrain-ment Rating (Number of Diversions)**	**Percent Flow Diverted**
		SNASO-s	Asotin Creek	1.164	6.120	4.677	1.198	27.120	NA	7.960	59.625	1.506	415	0.7774
	Clearwater River	CRLMA-s	Clearwater lower mainstem	0.514	4.136	5.161	1.474	NA	NA	9.469	23.816	1.492	581	1.7540
		CRNFC-s	North Fork Clearwater (historic)	0.012	0.047	1.026	2.029	NA	NA	0.085	0.045	1.002	322	NA
		CRLOL-s	Lolo Creek	0.132	0.479	1.244	2.181	NA	NA	0.000	0.494	1.085	336	0.0000
		CRLOC-s	Lochsa River	0.007	0.007	1.000	1.553	NA	NA	0.000	0.000	1.005	381	0.0042
		CRSEL-s	Selway Reiver	0.005	0.005	1.000	1.169	NA	NA	0.000	0.000	1.000	388	0.0549
		CRSFC-s	South Fork Clearwater River	0.004	0.033	1.033	1.817	NA	NA	0.000	0.000	1.003	429	1.5055
	Grande Ronde River	GRLMT-s	Grande Rone lower mainstem tribs	0.477	2.167	2.144	1.744	2.350	NA	0.227	12.610	1.149	NA	NA
		GRJOS-s	Joseph Creek	0.574	1.194	1.555	1.588	3.600	NA	0.714	0.642	1.005	308	0.2833
		GRWAL-s	Wallowa River	0.282	0.922	1.712	1.404	28.100	NA	25.388	22.001	1.151	536	52.2694
		GRUMA-s	Grande Ronde Upper Mainstem	0.185	0.551	1.529	2.135	32.190	NA	12.730	9.344	1.139	720	0.9113
	Salmon River	SRLSR-s	Little Salmon and Rapid Rivers	0.443	1.958	1.987	1.818	0.000	32.739	0.194	12.470	1.063	494	12.1731
		SRCHA-s	Chamberlain Creek	0.091	0.092	1.000	1.253	NA	2.191	1.275	1.189	1.004	362	2.2330
		SFSEC-s	Secesh River	0.000	0.000	1.000	1.475	NA	0.000	0.955	0.591	1.000	349	0.0310
		SFSFS-s	South Fork Salmon River	0.035	0.035	1.000	1.352	NA	2.821	1.066	0.799	1.007	361	0.6165
		SRPAN-s	Panther Creek	0.211	0.211	1.000	1.294	NA	0.731	1.588	1.264	1.000	368	1.4837
		MFBIG-s	Big, Camas, and Loon Creeks	0.535	0.535	1.000	1.036	NA	0.016	0.805	0.549	1.000	356	0.5746
		MFUMA-s	Middle Fork Salmon River Upper Mainstem	0.211	0.211	1.000	1.027	NA	0.121	0.269	0.558	1.001	353	0.6084
		SRNFS-s	North Fork Salmon River	0.198	0.198	1.000	1.640	NA	9.948	6.586	10.903	1.009	413	2.3686
		SRLEM-s	Lemhi River	0.607	0.690	1.062	1.230	NA	35.695	44.524	22.634	1.095	891	52.1599
		SRPAH-s	Pahsimeroi River	1.173	1.192	1.008	1.176	5.920	17.709	24.668	12.929	1.049	594	44.7873

				NONFOREST SEDIMENT			Forest Sediment	Flood-plain		Riparian		*Toxics*	Diversions	
ESU	**Major Population Grouping**	**Current Pop. Code**	**Population Name**	**Historical**	**Current**	**Increase**	**INCREASE**	**Avg % area converted (potential range)**	**Avg % stream length converted (potential range)**	**Percent converted (current range)**	**Percent converted (potential range)**	**Avg water quality rating**	**Entrain-ment Rating (Number of Diversions)**	**Percent Flow Diverted**
		SREFS-s	East Fork Salmon River	1.394	1.401	1.003	1.113	11.220	21.457	12.141	11.187	1.029	801	24.6766
		SRUMA-s	Salmon River upper mainstem	0.314	0.314	1.000	1.252	3.660	5.426	4.766	4.993	1.048	721	8.3384
	Hells Canyon	SNHCT-s	Snake River Hells Canyon Tributaries	0.785	1.481	1.359	1.252	NA	NA	0.000	0.000	1.005	292	0.0346
	Imnaha River	IRMAI-s	Imnaha River	0.594	1.211	1.427	1.327	NA	NA	0.103	0.113	1.002	343	0.8399
Upper Columbia Steelhead	Upper Columbia	UCWEN-s	Wenatchee River	0.142	0.308	1.043	1.778	12.930	NA	4.161	12.121	1.178	581	1.7453
		UCENT-s	Entiat River	0.093	0.132	1.009	2.179	20.250	NA	4.756	6.860	1.059	580	0.5060
		UCMET-s	Methow River	0.130	0.225	1.064	1.603	4.290	NA	10.043	10.215	1.077	840	3.7405
		UCOKA-s	Okanogan River	0.449	0.670	1.188	1.229	21.770	NA	NA	NA	1.660	903	69.2964

Table 2. Summary of potential for improvement in population status. An "X" indicates that there is potential to improve population status for that parameter. See Appendix D for specific details.

ESU	Population Name	Potential for Population Improvement			
		Abundance	*Productivity*	*Spatial Structure*	*Diversity*
Snake River Spring/Summer Chinook					
	Asotin River	X	*	X	X
	Tucannon River	X	X	X	
	Wenaha River	X	X	X	X
	Wallowa/Lostine Rivers	X	X	X	X
	Lookingglass Creek (Historic)	X	X	X	X
	Minam River	X	X	X	
	Catherine Creek	X	X	X	
	Upper Grande Ronde River	X	X	X	X
	Imnaha River	X	X	X	
	Big Sheep Creek	X	X	X	
	Little Salmon River	X	X	X	X
	South Fork Salmon River	X	X	X	X
	Secesh River	X	X	X	
	E Fk S Fk Salmon River	X	*	X	
	Chamberlain Creek	X	X	X	
	Big Creek	X	X	X	
	Lower Middle Fork Salmon River	X	*	X[1]	
	Camas Creek	X	X	X	
	Loon Creek		X		
	Upper Middle Fork Salmon River	X	*	X	
	Sulphur Creek	X	X		
	Bear Valley Creek	X	X		
	Marsh Creek	X	X		
	Panther Creek (Historic)	X	X	X	X
	N Fk Salmon River	X	X	X	X
	Lemhi River	X	X	X	X
	Upper Salmon Lower Mainstem	X	*	X	
	Pahsimeroi River	X		X	X
	E Fk Salmon River	X	X	X	
	Yankee Fork		X		
	Valley Creek		X		
	Upper Salmon River	X	X	X	
Upper Columbia Chinook					
	Entiat River	X	X	X	X
	Methow River	X	X	X	X
	Wenatchee River	X	X	X	X
Snake River Fall Chinook					
	Snake mainstem and lower tributaries		X	*	*

*** No Data**

[1] Note that the database of current population provided to us does not include the extent of summer spawning. Thus, the actual value underlying this designation is likely to be in error.

Table 2. Continued

ESU	Population Name	Potential for Population Improvement			
		Abundance	*Productivity*	*Spatial Structure*	*Diversity*
Middle Columbia Steelhead					
	While Salmon River (Historic)	X	*	X	X
	Klickitat River	X		X	X
	Fifteen Mile Creek (winters)	X			
	Deschutes River, Eastside	X	X		
	Deschutes River, Westside	X		X	X
	Rock Creek	X	*	X	
	John Day River lower mainstem tribs	X	X	X	
	North Fork John Day River	X	X		
	Middle Fork John Day River	X	X		
	South Fork John Day River	X	X	X	
	John Day upper mainstem	X	X	X	
	Umatilla River	X	X	X	X
	Walla Walla River	X	Insufficient data	X	X
	Touchet River	X	X	X	X
	Toppenish and Satus Creeks	X	*	X	X
	Naches River	X	*	X	
	Yakima River upper mainstem	X		X	X
Snake River Steelhead					
	Tucannon River	X	X	X	X
	Asotin Creek	X	X	X	X
	Clearwater lower mainstem	X	*	X	X
	North Fork Clearwater (historic)	X	*	X	X
	Lolo Creek	X	*	X	
	Lochsa River	X	*	X	
	Selway Reiver	X	*	X	
	South Fork Clearwater River	X	*		
	Grande Rone lower mainstem tribs	X	*		
	Joseph Creek	X			
	Wallowa River	X			
	Grande Ronde Upper Mainstem	X	X		X
	Little Salmon and Rapid Rivers	X	*	X	
	Chamberlain Creek	X	*		
	Secesh River	X	*	X	
	South Fork Salmon River	X	*		
	Panther Creek	X	*	X	
	Big, Camas, and Loon Creeks	X	*		
	Middle Fork Salmon River Upper Mainstem	X	*		
	North Fork Salmon River	X	*		
	Lemhi River	X	*	X	
	Pahsimeroi River	X	*	X	X
	East Fork Salmon River	X	*	X	X
	Salmon River upper mainstem	X	*	X	
	Snake River Hells Canyon Tributaries	X	*	X	X
	Imnaha River	X	X		X

*** No Data**

Table 2. Continued

ESU	Population Name	Potential for Population Improvement			
		Abundance	*Productivity*	*Spatial Structure*	*Diversity*
Upper Columbia Steelhead					
	Wenatchee River	X	X	X	X
	Entiat River	X	X	X	X
	Methow River	X	X	X	X
	Okanogan River	X	*	X	X
Columbia River Chum					
	Youngs Bay		*	X	X
	Grays River (Hymer)	X	X	X	
	Grays River (Rawding)			X	
	Big Creek		*	X	X
	Elochoman River		*		
	Clatskanie River		*	X	
	Mill, Abernathy, Germany		*	X	X
	Scappoose Creek		*	X	X
	Cowlitz River		*	X	X
	Kalama River	X	*	X	X
	Lewis River		*	X	X
	Salmon Creek		*	X	X
	Clackamas River		*	X	X
	Sandy River	X	*	X	X
	Washougal river		*	X	X
	Lower Gorge Tributaries	X	X	X	
Snake River Sockeye					
	Redfish Lake	X	X	X	X

Table 3. Population-specific ranking of relative impairment for seven freshwater habitat factors. A high score indicates that the habitat factor has a higher probability of being impaired for that population.

ESU and Major Population Grouping	**Current Pop. Code**	**Population Name**	**Increase in non-forest sediment**	**Increase in forest sediment**	**Floodplain Conversion-Fema maps**	**Floodplain Conversion-FEMA maps unavailable**	**Riparian Conversion**	**Toxics**	**Entrainment Rating**	**In-stream flow**	**# of factors with score ∃8**	**# of factors with score ∃6**
Snake River Spring / Summer Chinook												
Lower Snake River	SNASO	Asotin River	10	7	6	NA	8	9	2	2	3	5
	SNTUC	Tucannon River	10	4	9	NA	10	9	3	5	4	4
Grande Ronde / Imnaha	GRWEN	Wenaha River	4	5	2	NA	1	2	1	8	1	1
	GRLOS	Wallowa/Lostine Rivers	9	6	10	NA	9	8	7	8	5	7
	GRLOO	Lookingglass Creek (historic)	4	10	1	NA	1	1	2	9	2	2
	GRMIN	Minam River	7	2	2	NA	3	2	NA	NA	0	1
	GRCAT	Catherine Creek	8	8	10	NA	8	9	9	8	7	7
	GRUMA	Upper Grande Ronde River	6	9	7	NA	3	6	6	2	1	5
	IRMAI	Imnaha River	6	3	NA	NA	1	2	3	3	0	1
	IRBSH	Big Sheep Creek	9	5	NA	NA	2	2	2	3	1	1
South Fork Salmon River	SRLSR	Little Salmon River	8	8	NA	10	6	4	7	8	4	6
	SFMAI	South Fork Salmon River	3	5	NA	6	4	3	5	6	0	2
	SFSEC	Secesh River	1	6	NA	1	3	1	4	1	0	1
	SFEFS	E Fk S Fk Salmon River	1	5	NA	7	4	4	4	3	0	1
Middle Fork Salmon River	SRCHA	Chamberlain Creek	1	2	NA	1	2	2	3	3	0	0
	MFBIG	Big Creek	1	1	NA	1	2	1	5	3	0	0
	MFLMA	Lower Middle Fork Salmon River	1	1	NA	5	3	1	4	3	0	0
	MFCAM	Camas Creek	1	2	NA	1	2	1	4	2	0	0
	MFLOO	Loon Creek	1	1	NA	1	4	1	3	1	0	0
	MFUMA	Upper Middle Fork Salmon River	1	1	NA	1	3	1	4	3	0	0
	MFSUL	Sulphur Creek	1	1	NA	6	4	3	3	NA	0	1
	MFBEA	Bear Valley Creek	1	1	NA	1	1	1	4	NA	0	0
	MFMAR	Marsh Creek	1	1	NA	1	2	2	4	2	0	0

ESU and Major Population Grouping	Current Pop. Code	Population Name	Increase in non-forest sediment	Increase in forest sediment	Floodplain Conversion- Fema maps	Floodplain Conversion- FEMA maps unavailable	Riparian Conversion	Toxics	Entrainment Rating	In-stream flow	# of factors with score ∃8	# of factors with score ∃6
Upper Salmon River	SRPAN	Panther Creek (historic)	1	5	1	5	4	1	5	5	0	0
	SRNFS	N Fk Salmon River	1	7	NA	8	6	4	6	7	1	5
	SRLEM	Lemhi River	5	3	NA	10	8	7	10	10	4	5
	SRLMA	Lower Salmon River	4	2	6	9	7	5	10	10	2	4
	SRPAH	Pahsimeroi River	4	2	4	8	7	5	8	10	2	3
	SREFS	E Fk Salmon River	1	1	1	7	4	2	9	6	1	2
	SRYFS	Yankee Fork	1	4	1	1	1	1	8	2	1	1
	SRVAL	Valley Creek	1	3	3	8	7	5	9	5	1	2
	SRUMA	Upper Salmon River	1	4	4	7	5	6	9	7	1	3
Snake River Fall Chinook												
Snake River	SNTUC	Tucannon River - North	5	4	9	NA	10	9	NA	NA	3	3
	SNTUC	Tucannon River - South	10	4	9	NA	10	9	NA	NA	4	4
	GRLMT	Grande Ronde River lower mainstem tributary	9	7	3	NA	7	7	2	7	1	5
	CRLMA	Clearwater River lower mainstem	10	5	NA	NA	9	9	NA	NA	3	3
	SRLSR	Little Salmon and Rapid River	8	6	1	9	6	5	NA	NA	1	3
	SNHCT	Snake River Hells Canyon tributaries	7	3	NA	NA	1	3	NA	NA	0	1
	IRMAI	Imnaha River mainstem	6	3	NA	NA	1	2	NA	NA	0	1
Upper Columbia Chinook												
Upper Columbia	UCENT	Entiat River	4	9	7	NA	5	5	8	4	2	3
	UCMET	Methow River	5	6	3	NA	6	6	10	7	1	5
		Okanogan River (historic)	10	6	2	NA	6	8	NA	NA	2	4
	UCWEN	Wenatchee River	4	7	6	NA	7	8	8	6	2	6
Lower Columbia Chum												
Lower Columbia	GRAY-CM	Grays & Chinook Rivers	6	10	5	NA	8	5	NA	NA	2	3
	YOUN-CM	Youngs Bay	6	10	5	NA	8	6	NA	NA	2	4
	BIGC-CM	Big Creek	7	10	8	NA	1	6	NA	NA	2	4
	ELOC-CM	Elochoman River	8	10	9	NA	10	7	NA	NA	4	5

ESU and Major Population Grouping	Current Pop. Code	Population Name	Increase in non-forest sediment	Increase in forest sediment	Floodplain Conversion-Fema maps	Floodplain Conversion-FEMA maps unavailable	Riparian Conversion	Toxics	Entrainment Rating	In-stream flow	# of factors with score ∃8	# of factors with score ∃6
	CLAT-CM	Clatskanie River	8	9	7	NA	5	8	NA	NA	3	4
	MILL-CM	Mill Creek	7	10	4	NA	6	10	NA	NA	2	4
	COWL-CM	Cowlitz River	9	10	8	NA	8	9	NA	NA	5	5
	KALA-CM	Kalama River	4	10	5	NA	9	6	NA	NA	2	3
	SCAP-CM	Scappoose River	9	9	8	NA	9	10	NA	NA	5	5
	LEWS-CM	Lewis River	8	10	6	NA	9	9	NA	NA	4	5
	SALM-CM	Salmon Creek	10	8	10	NA	10	10	NA	NA	5	5
	CLCK-CM	Clackamas River	7	8	10	NA	10	10	NA	NA	4	5
	WASH-CM	Washougal River	9	10	6	NA	8	10	NA	NA	4	5
	SAND-CM	Sandy River	8	9	5	NA	8	10	NA	NA	4	4
	LGRG-CM	Lower Gorge Tributaries	5	8	7	NA	8	6	NA	NA	2	4
	UGRG-CM	Upper Gorge Tributaries	6	8	5	NA	9	8	NA	NA	3	4
Snake River Sockeye												
Upper Salmon River	SRRED	Redfish Lake	1	1	NA	1	NA	3	NA	NA	0	0
	SRRED	Alturas Lake	1	4	NA	1	NA	4	NA	NA	0	0
	SRRED	Petit Lake	1	2	NA	1	NA	5	NA	NA	0	0
Middle Columbia Steelhead												
Cascade Eastern Slope Tributaries	MCWSA-s	While Salmon River (historic)	1	9	2	NA	2	7	1	2	1	2
	MCKLI-s	Klickitat River	7	10	5	NA	5	7	1	7	1	4
	MCFIF-s	Fifteen Mile Creek (winters)	9	7	10	NA	9	9	1	5	4	5
	DREST-s	Deschutes River, Eastside	7	3	7	NA	6	7	1	9	1	5
	DRWST-s	Deschutes River, Westside	5	5	3	NA	2	5	1	1	0	0
		Crooked River - Above Pelton Dam (historic)	5	5	2	NA	5	6	NA	NA	0	1
	DRUMA-s	Upper Deschutes/Squaw creek - Above Pelton Dam (historic)	6	7	2	NA	5	8	NA	NA	1	3
	MCROC-s	Rock Creek	9	5	2	NA	4	7	1	NA	1	2

ESU and Major Population Grouping	**Current Pop. Code**	**Population Name**	**Increase in non-forest sediment**	**Increase in forest sediment**	**Floodplain Conversion-Fema maps**	**Floodplain Conversion-FEMA maps unavailable**	**Riparian Conversion**	**Toxics**	**Entrainment Rating**	**In-stream flow**	**# of factors with score ∃8**	**# of factors with score ∃6**
John Day River	JDLMT-s	John Day River lower mainstem tribs	6	3	6	NA	8	7	6	9	2	6
	JDNFJ-s	North Fork John Day River	5	9	4	NA	4	4	6	6	1	3
	JDMFJ-s	Middle Fork John Day River	7	9	NA	NA	5	4	6	7	1	4
	JDSFJ-s	South Fork John Day River	4	7	NA	NA	5	2	2	6	0	2
	JDUMA-s	John Day upper mainstem	5	8	NA	NA	9	5	9	9	4	4
Umatilla and Walla Walla Rivers	MCUMA-s	Umatilla	10	5	9	NA	9	9	7	9	5	6
	WWMAI-s	Walla Walla River	9	4	10	NA	10	10	10	10	6	6
	WWTOU-s	Touchet River	10	2	10	NA	10	10	7	8	5	6
Yakima River Group	YRTOS-s	Toppenish ans Satus Creeks	7	6	4	NA	5	8	2	2	1	3
	YRNAC-s	Naches River	6	7	8	NA	7	8	9	8	4	7
	YRUMA-s	Yakima River upper mainstem	6	8	8	NA	9	8	10	9	6	7
Snake River Steelhead												
Lower Snake	SNTUC-s	Tucannon River	10	4	9	NA	10	9	3	5	4	4
	SNASO-s	Asotin Creek	10	2	8	NA	10	10	7	4	4	5
Clearwater River	CRLMA-s	Clearwater lower mainstem	10	5	NA	NA	9	10	8	6	4	5
	CRNFC-s	North Fork Clearwater (Historic)	4	8	NA	NA	2	2	2	NA	1	1
	CRLOL-s	Lolo Creek	7	9	NA	NA	3	7	3	1	1	3
	CRLOC-s	Lochsa River	1	6	NA	NA	1	3	6	1	0	2
	CRSEL-s	Selway Reiver	1	2	NA	NA	1	1	6	2	0	1
	CRSFC-s	South Fork Clearwater River	4	8	NA	NA	1	2	7	5	1	2
Grande Ronde River	GRLMT-s	Grande Ronde lower mainstem tribs	9	7	3	NA	7	7	NA	NA	1	4
	GRJOS-s	Joseph Creek	8	6	3	NA	3	3	2	3	1	2
	GRWAL-s	Wallowa River	8	5	8	NA	8	8	7	10	5	6
	GRUMA-s	Grande Ronde Upper Mainstem	8	9	9	NA	6	7	9	5	4	6

ESU and Major Population Grouping	Current Pop. Code	Population Name	Increase in non-forest sediment	Increase in forest sediment	Floodplain Conversion-Fema maps	Floodplain Conversion-FEMA maps unavailable	Riparian Conversion	Toxics	Entrainment Rating	In-stream flow	# of factors with score ∃8	# of factors with score ∃6
Salmon River	SRLSR-s	Little Salmon and Rapid Rivers	9	8	1	10	7	6	7	9	3	6
	SRCHA-s	Chamberlain Creek	1	3	NA	6	4	3	5	6	0	2
	SFSEC-s	Secesh River	1	6	NA	1	3	1	4	1	0	1
	SFSFS-s	South Fork Salmon River	1	4	NA	6	3	4	5	4	0	1
	SRPAN-s	Panther Creek	1	4	NA	5	4	1	5	5	0	0
	MFBIG-s	Big, Camas, and Loon Creeks	1	1	NA	4	3	1	5	4	0	0
	MFUMA-s	Middle Fork Salmon River Upper Mainstem	1	1	NA	4	3	2	5	4	0	0
	SRNFS-s	North Fork Salmon River	1	7	NA	8	6	4	6	7	1	5
	SRLEM-s	Lemhi River	5	3	NA	10	8	7	10	10	4	5
	SRPAH-s	Pahsimeroi River	4	2	4	9	7	5	8	10	2	3
	SREFS-s	East Fork Salmon River	3	2	5	9	6	4	10	9	2	3
	SRUMA-s	Salmon River upper mainstem	1	3	3	7	5	5	9	8	2	2
Hells Canyon	SNHCT-s	Snake River Hells Canyon Tributaries	7	3	NA	NA	1	3	1	1	0	1
Imnaha River	IRMAI-s	Imnaha River	8	4	NA	NA	2	2	3	4	1	1
Upper Columbia Steelhead												
Upper Columbia	UCWEN-s	Wenatchee River	4	7	6	NA	7	8	8	6	2	6
	UCENT-s	Entiat River	4	9	7	NA	5	5	8	4	2	3
	UCMET-s	Methow River	5	6	3	NA	6	6	10	7	1	5
	UCOKA-s	Okanogan River	6	3	7	NA	NA	10	10	10	3	5

Table 4. Salmon and steelhead populations categorized by degree of impact and population status. In this table, habitat was considered compromised with respect to a particular factor if it fell within the top thirty percent of the distribution of the factor (i.e. in the top three bins, each bin comprising 10% of the range of values for each factor). THIS IS A RELATIVELY STRINGENT DEFINITION OF COMPROMISED. Populations exhibiting relatively less poor population status are those that were impaired with respect to only one or two VSP parameters – these are in bold in the “minimally compromised habitat” column. Populations in italics in the “moderately compromised habitat column are those for which identified impacts are restricted to ONLY instream flow and/or diversion entrainment We did not include any assessment of areas blocked to anadromous salmonids, although we anticipate that we will provide this information in the next version of this paper. Extirpated populations not included in this table.

ESU	**Minimally compromised habitat (no tributary habitat factors identified as impaired)**	**Moderately compromised habitat (1-3 tributary habitat factors identified as impaired)**	**Highly compromised habitat (4-7 tributary habitat factors identified as impaired)**
Snake River spring/summer chinook	Minam River Imnaha River South Fork Salmon River[1] Secesh River[1] Chamberlain Creek Big Creek Lower Middle Fork Salmon R. Camas Creek **Loon Creek** Upper Middle Fork Salmon R. Sulphur Creek Bear Valley Creek Marsh Creek[1]	Asotin Creek *Wenaha River* Upper Grande Ronde River Big Sheep Creek N Fk Salmon River *Upper Salmon River (lower mainstem)* *Pahsimeroi River* E Fork Salmon River Yankee Fork[2] *Valley Creek* *Upper Salmon River (upper)*	Tucannon River Wallowa/Lostine Rivers Catherine Creek Little Salmon River Lemhi River

[1] See discussion under “ESU and population-specific discussion” for additional information

[1] Panther Creek and the East Fork South Fork both fell in this category on the basis of our analyses. We did not include them, however, due to known historic mining impacts.
[2] Yankee Fork also has substantial mining impacts not accounted for in this analysis.

ESU	Minimally compromised habitat (no tributary habitat factors identified as impaired)	Moderately compromised habitat (1-3 tributary habitat factors identified as impaired)	Highly compromised habitat (4-7 tributary habitat factors identified as impaired)
Upper Columbia spring chinook		Wenatchee River Entiat River *Methow River*	
Snake River steelhead	Lochsa River Selway River **Chamberlain Creek** Secesh River[4] South Fork Salmon River[4] **Big, Camas and Loon Creeks** **Middle Fork Salmon, upper mainstem** Snake River Hells Canyon tributaries	Lolo Creek South Fork Clearwater River Grande Ronde, lower mainstem Joseph Creek Little Salmon and Rapid Rivers North Fork Salmon River *Pahsimeroi River* *East Fork Salmon River* *Salmon River upper mainstem* Imnaha River	Tucannon River Asotin Creek Clearwater R., lower mainstem Wallowa River Grande Ronde Upper Mainstem Lemhi River
Upper Columbia steelhead		Wenatchee River Entiat River *Methow River* Okanogan River	
Mid-Columbia steelhead	Deschutes River, Westside South Fork John Day River	Klickitat River *Deschutes River, Eastside* Rock Creek John Day, lower mainstem tribs North Fork John Day River Middle Fork John Day River Toppenish and Satus Creeks	Fifteen Mile Creek John Day R., upper mainstem Umatilla River Walla Walla River Touchet River Naches River Yakima River, upper mainstem

[4] See text under “ESU and population-specific discussion for further information.

ESU	Minimally compromised habitat (no tributary habitat factors identified as impaired)	Moderately compromised habitat (1-3 tributary habitat factors identified as impaired)	Highly compromised habitat (4-7 tributary habitat factors identified as impaired)
Snake River fall chinook[1]	NA	NA	NA
Snake River sockeye	Redfish Lake		
Columbia River chum		Grays and Chinook Rivers Youngs Bay Big Creek Clatskanie River Mill Creek Kalama River Lower Gorge Tributaries Upper Gorge Tributaries	Elochoman River Cowlitz River Scappoose River Lewis River Salmon Creek Clackamas River Washougal River Sandy River

[1] See text under "ESU and population-specific discussion" for clarification.

Table 5. Salmon and steelhead populations categorized by degree of impact and population status. In this table, habitat was considered compromised with respect to a particular factor if it fell within the top fifty percent of the distribution of the factor (i.e. in the top five bins, each bin comprising 10% of the range of values for each factor). THIS IS A RELATIVELY RELAXED DEFINITION OF COMPROMISED. Populations exhibiting relatively less poor population status are those that were impaired with respect to only one or two VSP parameters – these are in bold in the "minimally compromised habitat" column. Populations in italics in the "moderately compromised habitat" column are those for which identified impacts are restricted to ONLY instream flow and/or diversion entrainment We did not include any assessment of areas blocked to anadromous salmonids, although we anticipate that we will provide this information in the next version of this paper. Extirpated populations not included in this table.

ESU	Minimally compromised habitat (no tributary habitat factors identified as impaired)	Moderately compromised habitat (1-3 tributary habitat factors identified as impaired)	Highly compromised habitat (4-7 tributary habitat factors identified as impaired)
Snake River spring/summer chinook	Chamberlain Creek Big Creek Lower Middle Fork Salmon R. Camas Creek **Loon Creek** Upper Middle Fork Salmon R. **Bear Valley Creek** **Marsh Creek[1]**	*Wenaha River* Minam River Imnaha River Big Sheep Creek South Fork Salmon River[1] Secesh River[1] Sulphur Creek *Pahsimeroi River* E Fork Salmon River Yankee Fork[2] Valley Creek Upper Salmon River (upper)	Asotin Creek Tucannon River Wallowa/Lostine Rivers Catherine Creek Upper Grande Ronde River Little Salmon River N Fk Salmon River Lemhi River Upper Salmon River (lower mainstem)

[1] Panther Creek and the East Fork South Fork both fell in this category on the basis of our analyses. We did not include them, however, due to known historic mining impacts.

[1] See discussion under "ESU and population-specific discussion" for additional information

[2] Yankee Fork also has substantial mining impacts not accounted for in this analysis.

ESU	Minimally compromised habitat (no tributary habitat factors identified as impaired)	Moderately compromised habitat (1-3 tributary habitat factors identified as impaired)	Highly compromised habitat (4-7 tributary habitat factors identified as impaired)
Upper Columbia spring chinook		Entiat River	Wenatchee River Methow River
Snake River steelhead	**Big, Camas and Loon Creeks** **Middle Fork Salmon, upper mainstem** Snake River Hells Canyon tributaries	Lolo Creek Lochsa River Selway River South Fork Clearwater River Joseph Creek Chamberlain Creek Secesh River[4] South Fork Salmon River[4] Pahsimeroi River East Fork Salmon River Salmon River upper mainstem Imnaha River	Tucannon River Asotin Creek Clearwater R., lower mainstem Grande Ronde, lower mainstem Wallowa River Grande Ronde Upper Mainstem Little Salmon and Rapid Rivers North Fork Salmon River Lemhi River
Upper Columbia steelhead		Entiat River	Wenatchee River Methow River Okanogan River

[4] See text under “ESU and population-specific discussion for further information.

ESU	Minimally compromised habitat (no tributary habitat factors identified as impaired)	Moderately compromised habitat (1-3 tributary habitat factors identified as impaired)	Highly compromised habitat (4-7 tributary habitat factors identified as impaired)
Mid-Columbia steelhead	Deschutes River, Westside	Rock Creek North Fork John Day River South Fork John Day River Toppenish and Satus Creeks	Klickitat River Deschutes River, Eastside Fifteen Mile Creek John Day, lower mainstem tribs Middle Fork John Day River John Day R., upper mainstem Umatilla River Walla Walla River Touchet River Naches River Yakima River, upper mainstem
Snake River fall chinook[1]	NA	NA	NA
Snake River sockeye	Redfish Lake		

[1] See text under "ESU and population-specific discussion" for clarification.

ESU	Minimally compromised habitat (no tributary habitat factors identified as impaired)	Moderately compromised habitat (1-3 tributary habitat factors identified as impaired)	Highly compromised habitat (4-7 tributary habitat factors identified as impaired)
Columbia River chum		Grays and Chinook Rivers Kalama River	Youngs Bay Big Creek Elochoman River Clatskanie River Mill Creek Cowlitz River Scappoose River Lewis River Salmon Creek Clackamas River Washougal River Sandy River Lower Gorge Tributaries Upper Gorge Tributaries